

High potential of affordable housing supply by using industrialised building system in Selangor

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Abstract. The implementation of an industrialized building system (IBS) by housing developers has been a subject of argument in terms of reducing the overall costs of the housing projects which aim to sustain the supply of affordable houses to the people. To date, no real-world study has been conducted into real business cases. Thus, this case study has been carried out to verify the utilization of IBS in reducing the construction cost of housing projects. Three case studies based on interviews were reviewed and analyzed using the content analysis approach. The findings showed that there were significant differences between utilizing the IBS approach compared to the conventional method. However, the factors of volumes, IBS supplier radius, land acquisition, design, type of residential units and construction company capacity are the main concerns which have been emphasized in applying the IBS method for affordable housing supply by the developers and manufacturers. The most interesting outcome was the fast completion of the construction projects which resulted in speeding up the claiming process. Thus, the implementation of IBS will enhance the developers' cash flow. This study concludes that the high potential of utilizing IBS components in affordable housing programs can be related to the overall reduction of construction costs, since more units were planned to be constructed in Selangor. However, the affordable housing program agencies should play a vital role in land acquisition.

1. Introduction

The rising cost of building materials has led to an incremental increase in housing costs [1,2] leading to increases in the market price which will outstrip rises in the median household income [3]. This situation will increase the number of 'overhang houses' and cause losses to the developers. According to a report by the National Property Information Centre (NAPIC) Malaysia, there was an increase in the number of overhang housing units from the year 2016 to 2018 in Selangor of 3,765 units valued at RM3,488.01 million [4]. The higher increment of overhang units was seen in the apartment/condominium type worth more than RM500K per unit. These values were far in excess of the calculated "median multiple income" approach [5,6] where the price of an affordable house should have been around RM260K in 2016 for the median income in Selangor compared to an estimated price of around RM302K in 2018. These difficult market conditions, driven by the rising demand for affordable housing, have led towards an effective business strategy model to meet the affordable



housing targets. This strategy urges further study to identify and justify effective proactive approaches to reduce construction costs. According to the previous studies, the implementation of IBS is economically effective in terms of cost. The analysis by Faghirinejadfard [7] using the tools of the Building Information Modeling method (BIM) has discovered that the implementation of IBS was proven to reduce building costs. This is due to the factor of fast project completion which has been taken into account in the overall operational cost. Despite the proposal of using precast units for housing construction, the economic performance remains a controversial issue among developers and contractors [8]. In discussing the utilization of IBS for the purpose of supplying affordable houses to the middle household income group (M40), this paper has undertaken a real case study to verify that by using IBS, the developers are capable of reducing construction costs and hence of increasing their ability to provide affordably-priced houses for customers. Therefore, this case study was conducted by analyzing three case studies in Selangor which incorporated the companies that fully implemented the IBS method and also integrated the IBS and conventional methods in their operations. The findings of this study will significantly help the stakeholders, especially the developers, to strategize their business model to cater for the affordable housing demand.

2. Literature review

There are many interchangeable terms which can be adopted at the international level in describing Industrialized Building Systems including ‘off-site’, ‘prefabricated components’ and ‘modern methods of construction’ [9]. Although various terms are used to describe the implementation of IBS, its objectives remain the same: to ensure good quality, cost effective products and to speed up the completion time [10]. According to Steinhard and Manley [11] the utilization of prefabrication technology has been adopted in many countries to meet a sudden demand spike in the market, e.g. in Malaysia where the demand for affordable houses was high and the supply-demand gap was huge [3]. Hence it was believed that the implementation of IBS would fill the gap.

The utilization of IBS is not something new in meeting housing demand, indeed it has been applied since the 1960’s for public housing projects [12]. The systems that were adopted at that time were mostly from foreign countries and were not fully adapted to Malaysia’s climate conditions [13,14]. However, due to some drawbacks of using IBS and the immature market for IBS in Malaysia, some companies have closed down their operations. Therefore, the government has been continuously promoting the utilization of IBS via training programs, public talks, incentive loans through the SME bank, and levy exemption considering the advantages of adopting IBS in the construction industry. The government has even issued a circular to help government projects achieve a 70% IBS Score and to encourage a 50% IBS Score for private projects [15] to boost the market demand for IBS utilization.

However, the adoption of IBS within the housing development business model has not yet been explored. This is appropriate to the case study undertaken by the Khazanah Research Institute (KRI) which found out that five housing developers with 15 years of experience in housing development did not create any incentives to invest in R&D to support construction technology that might enhance their productivity [6]. Later, the suggestion was proposed to the developers, but they were still in doubt, so the study has recommended that further studies on IBS should be expanded [1].

In order to achieve the objectives of this paper, the literature review is based on a comparison between the projects that used conventional and IBS methods, as summarized in the following table (Table 1). In short, the implementation of IBS is able to reduce the overall project cost by considering several factors. Shahzad [16] in his analysis has emphasized the calculation of productivity which he has reviewed for the whole process of the project. Meanwhile, Hong [8] has revealed that the utilization of precast components remained low in China, including the efforts to provide public housing as the cost is higher. Meanwhile, Faghirinejadfard [7] has discovered that cost reductions can be achieved through high-volume production (up to 200 housing units). A literature review by Noguchi [17] found that a prefabricated house is more expensive than a conventional one because of the quality value that purchasers gain from the end product.

Table1. Comparison between conventional methods and prefabrication technology.

| No | Authors | Country | Research Method | Analysis | Result (comparison with conventional method) | Building type |
|----|-------------------------------------|-------------|-------------------|-----------------------|--------------------------------------------------------|--------------------|
| 1 | Shahzad [16] | New Zealand | Mixed method | Marginal productivity | 34% and 19% reduction of time and cost | All building types |
| 2 | Hong <i>et al.</i> [8] | China | Mixed method | Cost-benefit analysis | Cost intensity higher 26.3 to 72.1%. | Residential |
| 3 | Faghirin-ejadfard <i>et al.</i> [7] | Malaysia | BIM simulation | Comparison | 26% of reduction | Single story house |
| 4 | Noguchi [17] | Japan | Literature review | Content analysis | 8% more expensive due to value of quality and warranty | Residential |

Generally, the Construction Industry Development Board (CIDB) have classified six types of IBS [18] namely:

1. Blockwork System
2. Reusable Formwork System
3. Timber Framing Systems
4. Precast Component System
5. Steel Frame System
6. Innovative System

Developers can use any type of IBS product as main components, temporary components or a combination of any product to supply to their housing projects. This requires partnership between both outside or internal suppliers (subsidiary companies) and the land acquisition owner (developer). The market for IBS products is expanding extensively with 300 IBS component suppliers in Malaysia recorded in February 2019 by the CIDB with 113 listed IBS suppliers located in Selangor state. The increase from year 2003 when only 21 IBS suppliers were recorded in Malaysia [12,19] is obvious.

Therefore, developers are able to utilize IBS products within their house building business model. Little research into business models for house building and construction companies has been conducted or discussed [20, 21]. A novel business model approach by Pan [20] discussed the uptake of prefabricated house-building business models in the United Kingdom (UK). He argues that the relationship between a business model, the factors capturing and creating value, and the uptake of off-site construction may not be as applicable in other countries. Meanwhile, Lessing and Brege [21] made a key contribution to understanding business models in the context of industrialized house building by identifying three cornerstones: the operational platform, market position and offering. Noor [22] proposed a concept for an innovative design system business model in tackling affordable housing in Malaysia but faced reluctance from developers. This was due to the resistance to changing from the conventional method to a new system. However, he cited that strong partnerships will determine the continuity of the supply chain of the project.

Basically, four main elements contributed to the overall housing cost [1]. The main elements are:

1. 20% land and land infra/site preparations,
2. 37% building and services,
3. 18% profit before tax (15% after tax),
4. 25% others (professional fees, regulatory costs, sales marketing, admin & general expenses, financing and contingencies).

The percentage of the housing cost was calculated based on the individual type of development and varied according to the projects and locations. The percentages of construction costs and services were higher compared to the other elements. Whilst based on data from the neighboring case study area to Selangor, Kuala Lumpur has recorded an increment in price of construction cost based on RM/ sq. ft. area (see Figures 1 and 2) and this is often reported as being the main contributor towards the increment of the housing prices [1]. The National Housing Department [2] also reported that there was an increment of 3% of material construction costs, which contributed about 64% of residential costs from year 2010 to 2015.

For the developers that have adopted the housing delivery system model, which is sell then build, they are very much dependent on the progressive claim for work done as verified by the architect to contribute to the smooth running of the project cash flow [20]. The ascending trend of sales of housing units compared to the market demand has boosted the progressive claim process that depends on the percentage of work done on-site. The promise of fast completion of the work done by using the IBS method was the one thing that helped the developers to sustain their business in offering affordable houses to the current market.

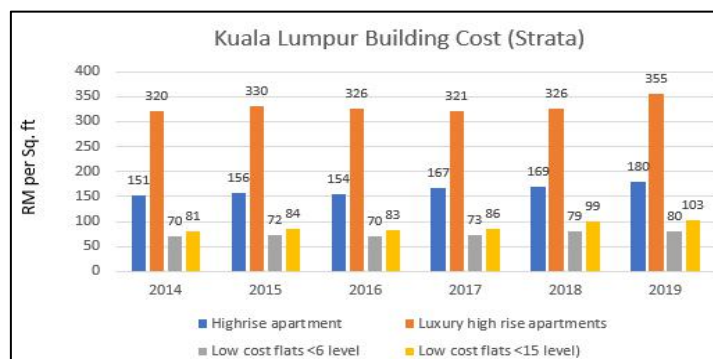


Figure 1. Construction Cost - Building (Strata) [1,21,22].

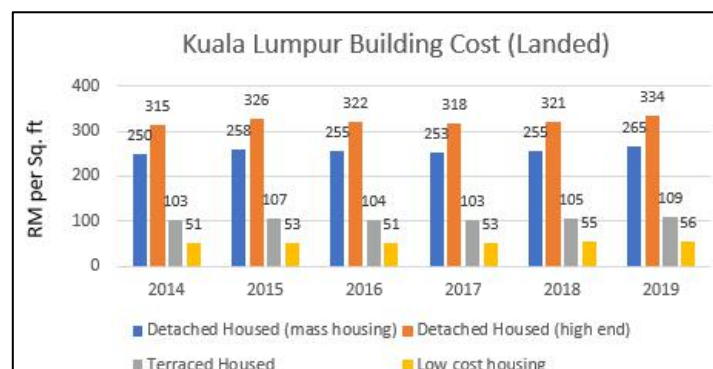


Figure 2. Construction Cost - Building (Landed) [1,21,22].

3. Research method

This paper has adopted the qualitative research method by interviewing six organizations that consist of three government agencies and three developer companies. The government agencies interviewed

are the responsible stakeholders on the issues of housing and IBS whilst the three developers have been chosen based on their utilization of IBS. To achieve its objectives, this paper will also respond to the calls for comparative analyses on the reduction of construction costs using IBS by presenting a cross-case analysis. Multiple case studies were investigated in order to refine and widen the empirical understanding of how the implementation of IBS in the affordable housing business model can reduce the overall cost whilst offering an affordable house price. Data were obtained by semi-structured interviews and a web search of documents. A three-step, cross-case, analytical procedure was carried out in which (1) the interviews were fully interpreted and qualitatively analyzed using a template coding procedure. Coding was executed using Atlas.ti8 and comprises several themes. The themes were divided in order to strengthen the understanding of factors concerned in using IBS for reducing cost. (2) To enhance the internal validity of the analysis, the results were triangulated in two ways. Firstly, in the coding process, the findings were named and compared crosswise with the interviews. Subsequently, the results from the coding procedure were validated through the web search for documents. (3) The coding and triangulation resulted in the analysis of the factors concerned in using IBS for reducing the building cost. Thus, to gain an understanding of the application of IBS within the developer business model, the results were cited in the form of case descriptions. This provided a better understanding of the configuration of the strategic factors applied to IBS in reducing building costs so that affordable house prices can be offered.

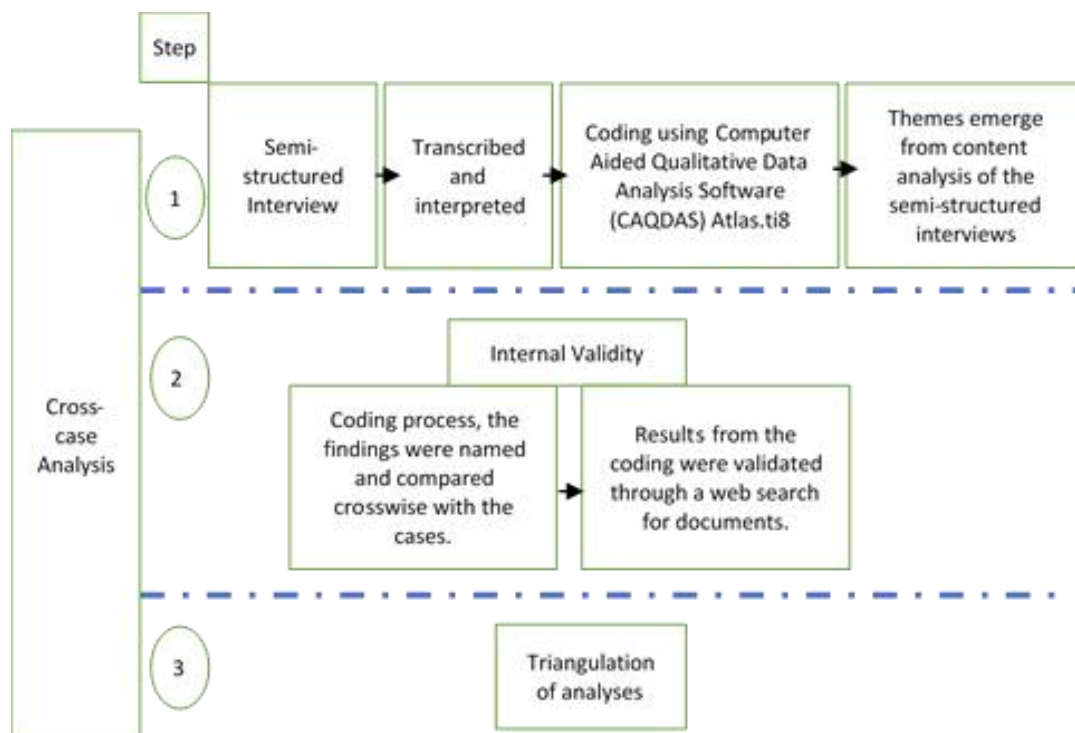


Figure 3. Research Method for Cross-case Analysis.

3.1. Study area

This study was focused in the state of Selangor which is located in the West of Peninsular Malaysia and adjacent to the two federal territories of Kuala Lumpur and Putrajaya. Selangor has been the biggest contributor to the gross output value for the Malaysia construction sector with a total amount of RM46.9 billion in the year of 2015 [23]. The construction sector in Selangor has been expanding with the percentage contribution amounting to 27.0% (RM55.2 billion) in 2017 [24]. In the fourth quarter of 2018, the value of construction work done was RM8.1 billion with the residential construction subsector in Selangor amounting to 32.1%. This consistent rise in the housing sector was

a sign of rapid economic growth in Selangor, along with the rising population and migration [25]. This state has also recorded the highest percentage of household income of the M40 group in Malaysia, as much as 26.4% [26]. Therefore, the market opportunity for providing affordable housing for the median multiple is huge. Despite that, the housing development had to follow the housing policy issued by the government of Selangor - the “Rumah Selangorku” policy - to replace the low-cost housing program in 2013 [27,28]. This policy has required any housing development projects to allocate a certain number of housing units at a fixed price ranging from RM42K to RM250K for each acre of land for the purpose of housing development. However, the units are limited and subjected to the qualification of application approval. Therefore, there was still some room for the private sector to make an effort to engage in the affordable housing market segment.

4. Findings and discussion

All in all, this multiple case study has proven that the utilization of prefabrication technology is able to reduce the overall building construction cost. A comparison between cases is summarized in Table 2.

Table 2. Differences identified within the case studies.

| Details | Case Study A | Case Study B | Case Study C |
|-------------------------------------------|--------------------------------|------------------------------------------------------|--------------------------------------|
| Target group | Low to middle-income. | For qualified Selangor citizens. Middle-income. | Middle-income. |
| Type of houses | Single unit house | Apartment | Apartment |
| Size | 1000 sq. ft. | 900 sq. ft. | 900-1200 sq. ft. |
| Land Acquisition | House purchaser owns the land. | Developer | Federal land |
| Types of IBS (material) | Various IBS types. | Precast concrete (off-site manufacturing). | Mix of IBS and conventional methods. |
| Gross Floor Area (GFA) price per sq. foot | RM65 | RM 105 | RM180-RM220 |
| Volume of production for reduction cost | 200 units | 500 units | 200-300 units |
| Price Range | RM65K | RM200K | RM300K |
| Radius from IBS supplier | NA. Bulk purchase. | 30km. | 50km. |
| Procurement and contract. | Closed tender. | Direct negotiation (in-house project with supplier). | Closed tender. |

4.1. Case Study A

This housing developer has been established for more than 20 years and focused on the low and middle-income groups. However, the construction of houses for the low-income group is limited and buyers should apply directly to the developers. This is due to the affordable housing program agreement between the developers and the government where the scheme is restricted. For the prospective purchaser from the low and middle-income groups, the opportunity to build a house is open to those buyers that have acquired their own land. The developers will utilize systems and products from foreign IBS suppliers and buy the products in bulk to get lower-cost materials. This strategy has been adopted to increase the economies of scale [8]. Furthermore, the developers can offer a type of standard housing design to the buyers. Despite that, inaccurate choices, such as using polystyrene foam from international IBS providers, have been the cause of several complaints from the occupants who stated that the house conditions were hotter than usual.

4.2. Case Study B

The establishment of this construction company and the internal partnering with the IBS supplier is of more than 23 years duration. Originally, the establishment of the IBS supplier began prior to 1980 when an external system from Japan was adopted by the local companies. In the year 2001, the local IBS supplier was able to run their business based on the previous experience in handling the system to be synchronized with the system from Japan. Altogether, the developers have acquired the land for development purposes in Selangor itself, and also in other states. The developers have accommodated the affordable housing market and also high-end housing projects. To fulfil the requirements of the “Rumah Selangorku” policy, the developers have implemented IBS together with local partners with the main aim being a move towards more local projects. The IBS partners have also become involved in government projects through open tendering, but did not participate directly with the foreign partnering developers, considering the solid and sufficient local project capacity. Through this IBS structure, developers can produce almost 1000 units per annum. To reduce the transportation cost, developers have strategized the location of the factory to be within an optimum distance of 30 km, so that the shipping of prefabricated precast products can be optimized. According to the interviewee, the changes in the use of IBS by developers were due to the fast progress of claiming for work done. The interviewee was also not denying that the probability of embarking on, or partnering with, the IBS supplier required a huge up-front financial commitment before the product can be manufactured. In addition, the apartment design was also influenced by the need to reduce costs.

4.3. Case Study C

This construction company was set up in the year 2013 during the transition to an affordable housing provision system in Malaysia. The developers were building houses not only in Selangor but throughout Malaysia and potential buyers in their affordable housing program had to apply online. The demand was high, but developers encountered complications concerning the ownership of the land. The tenancy of the land owned by the developer was subject to it not being needed by the federal and/or state governments. The high demands for the affordable houses in urban areas and limited government lands have made it difficult to erect a supply of affordable housing. These limitations have motivated developers to enter into strategic partnerships with other developers that have acquired the land to fulfil the demand for housing. Though the volume of the demand for housing was high, the developers were still using foreign IBS suppliers. Although the developers had the intention of establishing a collaboration partnership with a Japanese precast company for a local project, the limited availability of finance was the main obstruction to the partnering process. Also, developers were convinced that the foreign IBS suppliers also had the ability to offer a competitive price.

4.4. Summary of case studies

Overall, the three case studies have different business models for the land acquisition process and partnering with an IBS supplier. The developers that adopted the IBS technology have the ability to reduce the overall cost, which later helped them offer affordable housing prices. The technologies of the developer companies not only helped in providing affordable houses, but were also capable of sustaining the business profit at the rate of 18% annually. The difference in cost price per sq. ft. was about 38% with the take-up of prefabrication in the housing development business model and this finding is proven to be significant. The utilization of IBS has also succeeded in preserving the momentum of the rapid rate of progress in the sales of affordable housing units, which is appropriate given the sudden spike in demand for affordable housing properties. Although the demand for affordably priced housing was high, the availability of the current technologies should be able to promote the affordable housing supply, although the problem of land acquisition needed to be well-managed. The problems in government land acquisition which affected developers should be overcome so that the stock of affordable houses in urban areas can be increased.

5. Conclusion

As a conclusion, the high demand for affordably priced housing in Selangor has opened up more opportunities for the housing developers to infiltrate the target segment of M40. The advantages of the innovation and technology in this business model have positive implications for the reduction of construction costs, speeded up cash flows, and brought profit to the developers. However, there were some crucial factors that should be taken into account in achieving the goals of reducing the optimum cost price of GFA, namely the type of residence, the cost/GFA and size, and the IBS radius which is the most important factor in calculating the house price cost.

However, the developers that were not relying on government land and receiving high numbers of online applications as well as depending on foreign IBS suppliers experienced higher GFA cost demands. In certain cases where the developers did not have any problems with the land acquisition, choosing the right IBS method can also affect the customer satisfaction. The factor of social acceptance should also be taken into account so that the quality of the services offered can be improved. Overall, this paper has discussed the implementation and utilization of IBS via case studies. In total, two out of the three case studies have shown a significant impact on the reduction of the overall housing project costs. Future research should also focus on formulating the affordable house price for those constructed using the prefabrication method so that the actual affordable housing price can be offered to potential purchasers.

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